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TABLE OF CONTENTS*

		Page
The Horizon of Geography	Derwent Whittlesey	1
Climates of Texas	Richard Joel Russell	37
Physiographic Divisions of the Columbia Intermontane Province	Otis W. Freeman, J. D. Forrester and R. L. Lupher	53
Glacial Diversion of Drainage (with especial reference to the phenomenon of the "Lost Gorge")	O. D. von Engeln	79
Geographic Training, Wartime Research and Immediate Professional Objectives	Edward A. Ackerman	121
Recent Changes in the Concentration of Manufacturing	Alfred J. Wright	144
Geography in Off-Duty Educational Opportunities for Armed Forces	Alice Foster	167
Memorial to Nevin M. Fenneman	John L. Rich	181

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INDEX TO VOLUME XXXV, 1945

Annals of the Association of American Geographers

PAGE

ACKERMAN, EDWARD A., Geographic Training, Wartime Research and Immediate Professional Objectives 121
Armed Forces, Geography in Off-Duty Educational Opportunities for, by Alice Foster 167
Changes, Recent, in the Concentration of Manufacturing, by Alfred J. Wright ... 144
Climates of Texas, by Richard Joel Russell 37
Columbia Intermontane Province, Physiographic Divisions of the, by Otis W. Freeman, J. D. Forrester and R. L. Lupher 53
Concentration of Manufacturing, Recent Changes in the, by Alfred J. Wright ... 144
Drainage, Glacial Diversion of, (with especial reference to the phenomenon of the "Lost Gorge"), by O. D. von Engeln 79
Educational Opportunities for Armed Forces, Geography in Off-Duty, by Alice Foster 167
Fenneman, Nevin M., Memorial to, by John L. Rich 181
FORRESTER, J. D., FREEMAN, OTIS W., and LUPHER, R. L., Physiographic Divisions of the Columbia Intermontane Province 53
FOSTER, ALICE, Geography in Off-Duty Educational Opportunities for Armed Forces 167
FREEMAN, OTIS W., FORRESTER, J. D., and LUPHER, R. L., Physiographic Divisions of the Columbia Intermontane Province 53
Geographic Training, Wartime Research and Immediate Professional Objectives, by Edward A. Ackerman 121
Geography, The Horizon of, by Derwent Whittlesey 1
Geography in Off-Duty Educational Opportunities for Armed Forces, by Alice Foster 167
Glacial Diversion of Drainage (with especial reference to the phenomenon of the "Lost Gorge"), by O. D. von Engeln 79
Horizon of Geography, The, by Derwent Whittlesey 1
Immediate Professional Objectives, Geographic Training, Wartime Research and, by Edward A. Ackerman 121
Intermontane Province, Physiographic Divisions of the Columbia, by Otis W. Freeman, J. D. Forrester and R. L. Lupher 53
"Lost Gorge," The, a Phenomenon of Glacial Diversion of Drainage, by O. D. von Engeln 79
LUPHER, R. L., FREEMAN, OTIS W., and FORRESTER, J. D., Physiographic Divisions of the Columbia Intermontane Province 53
Manufacturing, Recent Changes in the Concentration of, by Alfred J. Wright ... 144
Memorial to Nevin M. Fenneman, by John L. Rich 181
Nevin M. Fenneman, Memorial to, by John L. Rich 181
Physiographic Divisions of the Columbia Intermontane Province, by Otis W. Freeman, J. D. Forrester and R. L. Lupher 53
Recent Changes in the Concentration of Manufacturing, by Alfred J. Wright ... 144

PAGE

Research, Wartime, and Immediate Professional Objectives, Geographic Training, by Edward A. Ackerman 121
RICH, JOHN L., Memorial to Nevin M. Fenneman 181
RUSSELL, RICHARD JOEL, Climates of Texas 37
Texas, Climates of, by Richard Joel Russell 37
Training, Geographic, Wartime Research and Immediate Professional Objectives, by Edward A. Ackerman 121
VON ENGELN, O. D., Glacial Diversion of Drainage (with especial reference to the phenomenon of the "Lost Gorge") 79
Wartime Research and Immediate Professional Objectives, Geographic Training, by Edward A. Ackerman 121
WHITTLESEY, DERWENT, The Horizon of Geography 1
WRIGHT, ALFRED J., Recent Changes in the Concentration of Manufacturing 144

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The Horizon of Geography

DERWENT WHITTLESEY*

PART ONE: THE EXPANDING SENSE OF SPACE; A CHRONOLOGICAL VIEW

If geography is man's way of setting down his understanding of the earth, then the significant stages in advancing geographic thought should be marked by notable extensions of man's comprehension of the earth-body. By common consent geography has relinquished a part of its original field to astronomy and to geology. Nowadays it is content to focus its attention upon that part of the earth-body subject to occupance or use by man.

Both in retrospect and in prospect, man *occupies* only the land surface of the earth—essentially a two-dimensional plane. Per contra, man *uses* not only the land surface, but also other parts of the earth-body—its surface waters, the depths of sea and land, and the heights of the air. The combined space occupied and otherwise used at any stage of human evolution constitutes the realm which encompasses man's geographic outlook at the time. Its confines fix the horizon of geography then current.

Variation in the Sense of Space

Mankind's sense of space varies widely at any epoch. Besides variation among individuals, there are group differences. Some of these are bound to economic limitations associated with contrasting habitats. Thus the subsistence farmer of Kashmir looks out upon a smaller and simpler world than the banker of Bombay. Others reflect different social opportunity even

* Professor Whittlesey prepared this paper as his presidential address to members of the Association of American Geographers at the time of their annual meetings in 1944. As in the preceding year, restrictions on travel made necessary by war-time conditions required the cancellation of the meetings, and members had not the opportunity to hear the paper read by its author.—*Ed.*

where the natural environment is similar; the Corn Belt farmer lives in a wider world than the peasant of North China. Still other dissimilarities apply to entire nations, and grow out of differences of location, resources, racial stock, and institutions (as, for instance, between Paraguay and Holland).

The wide range of outlook existing among contemporary societies of the globe is a powerful geographic deterrent to establishing a single worldwide political community. This is only one evidence of the practical force of variation. Nevertheless, it will be disregarded in the present inquiry as to what constitutes the geographic horizon, because it overloads the investigation with complications. For the sake of simplicity, it is desirable to define the geographic horizon as delimiting the sense of space current at or near the most advanced frontier of thought. It seems reasonable to believe that the whole of mankind will in time advance to this position. The expectation is warranted by the recorded enlargement of the sense of space from its primitive, pre-historic beginnings.

A broadening view of the earth may be instigated by persons of many sorts—not only explorers, but also itinerant merchants, mine prospectors, navigators, political leaders, or scholars. Such folk, imparting news of the area freshly embraced within their new horizon are at first greeted with incredulity. Shortly they are accepted by adventurous spirits. The added space, visited or heard of with increasing frequency, comes to affect the everyday life of many who are unaware of it. Finally it becomes familiar enough, through customary dealings, to take its place as part of the heritage of the whole social group. Some of the profoundest and most comprehensive changes in history have been the consequence of an extension of the sense of space.

The social group unified by a commonly accepted sense of space has grown from tiny distinct tribes to almost the whole of humanity. Today not many people are so isolated that they do not hear, at least indirectly, of the more shattering world events, wherever they may occur. The earth has become to this extent a unit, despite the variations already mentioned. At every epoch, the order-of-magnitude of space, as understood by the minority who grasp it and taken for granted by the larger number who live by it without thinking about it, is conditioned by the stage of communication attained at the place in question. By setting limits to the observation of the earth, communications and transport integrate the areas which they connect, both physically and conceptually.

Geographers welcome each projection of the sense of space as an addition to the inheritance they essay to comprehend and interpret. Humanity has progressed from the narrow horizons of discrete units isolated by unmastered

wastes to the universal view. By scrutinizing successive space-horizons from the most primitive known down to the present, it should be possible to determine the character and limits of geographic space in the present world of revolutionary technology and social adaptation.

The Primal Sense of Space

Primitive people commonly inhabit a narrowly restricted environment. Even though it covers a good deal of territory, as with nomads, it is uniform in character. Hence the outlook of the group is almost literally limited to the physical horizon. This may be the walls and canopy of the rain forest, the hilly or mountainous limits of a valley, the flat circle of a grassed plain, or any other landscape from which a primitive livelihood can be extorted. It is a two-dimensional world, because groups just barely able to keep alive with primitive tools have little energy or time to reach up into the sky or to dig far into the earth. They accept what they find at the earth's surface, although they may scratch the soil, open water holes, and scrape up minerals, such as salt and iron, from surficial deposits.

Such folk are largely "controlled" by their restrictive natural environment. They personalize the conditions of their life as gods having the faults and virtues of humankind. Their offerings to these gods are their misdirected efforts to bend nature to their desires. Their wars are tribal wars, fought between small groups of neighbors who as a rule share the scanty bounty of an environment uniform with their own. When a tribe shifts its locale, as it commonly does after a few years of extractive occupance, it exchanges one specific set of natural features for another very similiar.

The most primitive peoples use only generic names for the major place features of their world, apparently because the generic term suffices to describe the features they know. Thus "mountain," "river," "town," sufficiently differentiate the single examples which lie within the physical range of view and the mental image of the surrounding world.[1]

People who have not yet advanced far from this generic nomenclature and from the horizon of small radius which it describes, are not solely primitive tribesmen in out-of-the-way corners of the earth, relicts of primitive man. Until recently many denizens of the Southern Appalachians found no reason to learn the gazetteer name of their local village; "town" was all they ever needed to call it. The contemporary Chinese farmer portrayed in "The Good Earth" never had to use the name of his market town.

[1] Wright, J. K.: "The History of Geography," *Annals Association American Geographers*, 15 (1925), 192–201.

The Regional Sense of Space

Somewhere in the mists of proto-history, human groups joined forces or expanded into areas so extensive, or so distinctive in character, that they were forced to observe both the repetition and the diversification characteristic of earth features. This necessitated the use of place names, to distinguish similar but particular spots from each other. Many such names remain, vestiges of societies long since vanished or removed.[2] At that stage, each of the many peoples inhabiting the earth thought of the more or less varied area which it ranged over, and occupied in some degree, as its "universe."

Whether the occupance was lightly etched nomadism or deeply intrenched, sedentary, irrigation settlement, the "world" of such a folk group was the portion of the earth made accessible by lines of communication they had been able to devise. Such a world could come into existence as soon as a few adventurous individuals in one group made close contacts with neighboring groups. It was not necessary that every member of each group should intermingle with the others, or even be conscious of their existence. Contacts were generally of two sorts—trade and warfare. Fighting men who returned from abroad came back with first-hand knowledge that a wider world existed, and a partial but realistic view of both nature and culture in an environment more or less different from the one they had grown up in. Merchants, although perhaps fewer in number, had ampler opportunities to observe foreigners at leisure and to mingle with them.

Ages of intermittent tribal warfare interspersed with more peaceable commercial rivalry and exchange extended and improved the means of intercommunication. Political association became closer, either by conquest or by affiliation. The restricted outlook of the lesser habitats very slowly widened and merged into the horizons of larger, ascendant "worlds." The first climax of this era of great regions was reached 1800 to 2000 years ago. At that time two areas of subcontinental size separately achieved political unity based on effective internal communication.

Rome and China

The geographic horizon of every time and place can be measured with fair accuracy by the state of communication, the social solidarity, and the degree of political association.

Classical Rome reached its maximum areal extent in 117 A.D. Its coreland was the central peninsula of the Mediterranean Sea, and the enclosed sea itself was its center of gravity. All the Mediterranean coasts were firmly welded into unity by sea power. During this epoch the Romans,

[2] Taylor, Isaac: *Words and Places* (1864 and later), *passim.*

by origin an inland folk, for the first time in history laid down a web of paved roads for armies and traders throughout the Mediterranean region and far beyond it. Thereby they combined land power with seapower to create and defend the "world" of classical antiquity. The practical limits of this world were the Atlantic Ocean in the west, the cold-winter lands covered with coniferous forests in the north and northeast, and the broad belt of steppe in the east and desert in the south and southeast. Mapmakers of this period knew of the lands surrounding the Indian Ocean, from information brought by adventurers, merchants, and (as far as the Indus River) by armies. The sense of space of the leaders of thought in ancient Greece and Rome rested upon an intimate intermingling of land and sea that reached from the known "Western Ocean" to an assumed eastern continent.

China participated with Rome in creating the regional sense of space. In the very period when the Roman Empire was most extensive, Chinese governments first laid claim to an area crudely approximating China today.[3] A little later than the Romans, the Chinese began expanding along roads and footpaths trodden by beasts and by human porters. The Chinese state, like the Roman unity, was based on the articulation of land and water routes. Some centuries after the early expansion, rivers and canals came to carry the major load of heavy traffic and the warships which made up China's "river power."

Ancient Rome and ancient China were aware of each other, if only from fragmentary evidence furnished by precious or curious items that made their way from one to the other as rarities, passing from hand to hand in a long chain of merchants. Both the Romans and the Chinese were in some sort of contact with South Asia. In the northern Indian Ocean, mariners could navigate open water without a compass by keeping the well-defined monsoon on a given quarter. An alternative trade route lay across the dry basins and high mountains of inland Asia. Despite these tenuous connections the two worlds lay discrete in space, separated by desert and steppe, even though they occupied humid middle latitudes on the same continental mass and their geographic horizons coexisted in time.

The regional sense of space grasped by Classical Rome and China of the contemporary Han period, was a product of political unification. This had been forged largely by conquest and was maintained by military force. In time it was broken by political cleavage.

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[3] Herrmann, Albert: *Historical and Commercial Atlas of China* (1935), 122–3. This early China of the Han Period lacked the hill land and rugged coast between the Yangtse and Si river mouths, and its claim to the Red Basin and the Southwest was tenuous.

During all the centuries since, China has alternately fallen apart and reunited. With each change the pattern of its communications grew or shrivelled, particularly on the sparsely populated, landward borders. Step by step more of the south was annexed, and for sixteen centuries approximately the same territory has been incorporated in every reintegration of the Chinese state. These vicissitudes did not alter the structure of the state, which retained the form it had taken in its earliest unified expression. Always the geographic outlook has been conditioned by a uniform mode of life centered upon intensive cultivation of cereals, on land naturally flat or terraced. Other resources were disregarded: slopes became denuded under often repeated slash-and-burn agriculture; few minerals were known; maritime activity was intermittent and confined to the reach of indented coast between Hangchow Bay and Hong Kong. China's contribution to the regional sense of space did not progress, once the recurrent pattern of its life became fixed.

In Europe the extreme political disruption associated with feudalism submerged the Roman state once and for all. The concept persisted in a practical form in the Roman church, but medieval Europe rejected any obligation to further mundane knowledge. Enough commercial and intellectual intercourse persisted to inscribe Western and Central Europe within a single geographic horizon. New lands about the Baltic Sea tended to offset areal losses in Africa and Asia, and introduced novel environments and peoples into the world of inherited Roman nature and culture. On the whole, however, the regional view grasped by the Romans contracted, not to expand again until the renascence of classical learning ushered in the modern world. Then there blossomed in Western Europe a regional sense of space far outreaching that of Classical Antiquity.

The Dry Belt

While China was settling into its groove, and the seed of Roman ideas was germinating in Central and Western Europe, the intervening dry lands achieved occasional political unity and corresponding extension of the geographic horizon. Unity was imposed by military conquest resting on the prowess of nomadic horsemen in the treeless environment of desert and steppe. They incorporated oases in a commensal mode of life which they dominated. They overran the steppes traditionally adherent to both China and Europe. They penetrated such parts of the humid Eurasian margins as had been denuded of natural forest cover and so lay open to attack by cavalry.

The empires built upon these swiftly moving conquests were short-lived and separated by long periods of dissolution. Moreover, they grew from

different nuclei, and occupied territory only partly coterminous. Their contribution to the world's sense of space was three-fold, but its value is not easy to assess.

Astronomy was an eternal preoccupation of desert dwellers, and it flourished greatly under the relatively settled life associated with periods of imperial unity. The singleness of the universe has impressed itself upon mankind through observation of heavenly bodies. Its practical application to navigation, and so to enlargment of the sense of earth-space, was not made by dwellers of the interior Dry Belt. That was a contribution of maritime Europe, heir of desert astronomy by way of a triple lineage traced through Classical Greece, Arabic Iberia, and the Renascence.

Monotheistic religion is well known to have been a product of dry-land environment. Uniformity, vast spaces, seeming nearness to the celestial bodies, pitiless terrors for scattered individuals and small groups of people, unify this environment and conduce to a belief in singleness of daemonic purpose throughout this distinctive "world." Both Judaism and Islam arose among nomads, and in their original form still flourish best in dry lands.

Both religions have spread far beyond desert and steppe. Islam has become the dominant faith in considerable humid territory in Asia and Africa, while Judaism, and particularly its offshoot, Christianity, have been basic to the thinking of all those parts of the earth occupied by Europeans. The universality preached by both Christianity and Islam may be a reason for their strong tendency to proselyte. No other religions have reached so many parts of the earth or appealed to so many different peoples.

Ideas originating in the Dry Belt that have woven themselves into the space concepts of dwellers in humid lands are not readily evaluated. In contrast, the direct influence of the dry lands on marginal peoples they have dominated is unequivocal. A large fraction of India was politically unified by Moslem invaders and partly converted to Islam before the advent of the British with their system of hegemony. Blocs of Moslem population have become a major obstacle to Indian unity. Evanescent but extensive Moslem empires throve in the Sudan for several centuries, and persist in British colonies under the protection of "indirect rule." The Dry Belt adjacent to China has profoundly influenced Chinese civilization. As territory infested by raiding enemies, it compelled sedentary Chinese to evolve a compact mode of settlement, even where rice growing did not impose it. As territory claimed by China, it has broadened the Chinese view of the world.

On the borders of Europe the impress of the Dry Belt is well known but not always well remembered. The first wave of Mohammedan conquest separated the southern and western Mediterranean coastlands from the European society of which they had previously been an important part. A sub-

sequent wave similarly lopped off the Eastern Mediterranean lands and kept southeastern Europe in flux until the present generation. Central Asian people and institutions have been woven into the life of Russia from its beginnings, and continue to be so significant in Russian culture that many observers consider the Soviet Union a composite of Europe and Asia, distinct from both.

The tide of expansion from the Dry Belt into marginal Asia, Africa, and Europe was beginning to recede by the end of the 15th century. However profoundly it may have modified the geographic horizon of adjacent peoples, it never merged its concept of world unity with theirs. To the epoch of the Discoveries, which radically altered the sense of space throughout the world, Europe, China, and the Dry Belt remained distinct realms, unknown to each other, except as enemies or in the distorted shape of legends. The character of their governments was incommensurate, the pattern of their communications was not articulated, and their geographic horizons were diverse. Each of them, however, arrived at a regional sense of space far in advance of what had gone before. Each contributed something to the common fund of ideas which was set up by the initial realization of a world-wide sense of space.

Other Regions

Until the 15th century the vast extent of earth-space which lay beyond the oceans and the Sahara were worlds unknown to any Eurasian peoples. If a few ships had already bypassed the Sahara barrier, sure knowledge of their exploits was lost in legend. Whatever geographic horizons were perceived by the aborigines of Black Africa, Australia, the Pacific Islands, and the Americas, remained unknown to Eurasia. When the new worlds were discovered the narrow outlooks there prevailing were disregarded. Hence they did not modify the horizons of geography that had long been evolving in the Old World. Instead they merged into the worldwide horizon which was being brought into view along with the non-European parts of the earth.

Two dimensions inscribed both the narrow worlds of small societies and the "great regions" of Eurasia. Human beings could not descend beneath the surface of oceans, lakes, or streams for more than a few minutes, and they had no means of reaching levels of the atmosphere above their citadel towers. They made use of fish that could be caught by lines or nets. They penetrated the land for water or for minerals to depths of a few score feet. They speculated about the atmosphere, but neither investigated or understood it. In the vertical plane society had not progressed significantly beyond the stage of primitive man.

The Worldwide Sense of Space

Discovery of the unity of the world-ocean, on which the continental masses are spotted like islands, created a worldwide horizon for advanced thinkers. The flat earth, in which the geographic horizon was viewed as limiting a plane, i.e., merely an imaginary extension of the visual horizon, was supplanted by the concept of the spherical earth. This outreach came with dramatic abruptness at the end of the 15th century, with the initial voyages to India around Africa and westward to the Americas.

Origins

The Discoveries were the most immediate geographic result of a fundamental change in the orientation of Europe to Asia. The search for new ways around the Dry Belt was precipitated by closure of the long-established routes. It was directed by an enlarged and altered hypothesis of earth-space. It was engendered by the Renascence.

During the later Middle Ages, as accumulation of capital freed more and more people from day-long drudgery, some of the new-found leisure was used by scholars to revive the study of classical learning in its entirety, as distinct from the small portions that had been kept in circulation from ancient times. The resulting ferment set thoughtful Europeans free to explore the physical and intellectual universe of the ancients, and also opened the way to observation of the contemporary world and to generalization about it.

Among the heady drafts from the well-stocked cellar of Classical Antiquity, Renascence scholars found a Greek hypothesis of the earth's sphericity. They absorbed it and constructed charts and globes to visualize it. Observations that might verify or disprove the notion included the experiment of Columbus in sailing westward to discover a new route to lands known to exist far east of Europe. This spectacular test was itself made possible by inventions spun independently from the free flow of Renascence thought. Navigation of the open ocean in regions of variable winds had only recently been made feasible. The mariner's magnetic compass for observing direction had been known since the 12th century, but it was not given a practical form before the 14th. The astrolabe, for reading latitude, was a device of the ancients which came into use only after 1480.

Navigators and scholars shaped the hypothesis of the earth's sphericity into fact. Besides, they proved the size of the earth to be larger than had been imagined, thus further extending the geographic horizon.

Other inventions and contrivances of the time confirmed Europeans in their worldwide sense of space. Firearms gave them an advantage over inhabitants of the newly found worlds so powerful that small groups of intruders could overbear any people not similarly equipped. The trading

corporation was a device under which traffic and government advanced together into worlds so new as to be primitive, and so old as to make European society seem primitive by comparison. Printing with movable type disseminated information about current explorations cheaply to a rapidly growing reading public, and held out to the ambitious and the discontented a prospect of wealth or freedom in the new lands. Thus from half a dozen roots, the worldwide sense of space stemmed from the Renascence. It grew into general acceptance only with the fruition of Renascence thought.

Shaping by Communications and Politics

The seaways to India and to the Americas were found by men intent upon trade, supported in their quest by newly fledged national states. The worldwide horizon which resulted from their efforts was shaped by a variety of people to whom it opened opportunities. Businessmen made occasion to trade; missionaries went out to bring heathen into the fold of Christianity; adventurers sought fortunes in the new world; fugitives from society lost themselves on the new frontiers; settlers in quest of homes flooded into one or another of the new continents in intermittent spates.

The world thus being developed conformed to the alternation of sea and land, the configuration and the climates of the continents, and the cultural diversity of peoples encountered. Its form can be seen in the world-pattern of communications. The new ocean routes were the trunk lines that kept Europe in touch with all the other continents. From stations set up at convenient overseas havens, feeders ramified inland. Where possible, existing riverways, roads, and trails were incorporated or reoriented to serve the unifying network of communication by sea. Routes not fitting into this new worldwide pattern shrank to the stature of local minor ways.

Between Europe and the old societies of Asia contact was largely in the form of trade, particularly at the outset. For fifteen hundred years before the Discoveries, the regional systems of Eurasia had been in unorganized contact at a few naturally favored points, mostly on the land frontiers. These routes had served for limited operations only—luxury trade, warfare, and political patronage. They were short-circuited by the all-ocean highway, while roads leading inland from Asiatic seaports throve.

European trade with the new continents may have been no less important than with Asia, but it usually followed conquest of the primitive inhabitants and settlement over wide areas by European emigrants, as well. Few existing routes could be used as they stood, but trails of the aborigines traced the way followed by roads and later by rails. Practical folk thus engaged in creating a single system of worldwide communications insensibly widened the European outlook.

Europeans abroad were unwilling to accept the legal and political order they found in their new surroundings. Instead, they undertook to govern themselves in the coastal bases which were their points of contact with the world overseas. As need or opportunity arose, they extended their sway over indigenous peoples with whom they dealt, and pushed their business, their settlement, and their government inland.

Political connections between Europe and both the Old and New Worlds created a pattern of empires located on several or all the continents and facing more than one segment of the world ocean. Although the colonial empires were mutually exclusive and generally in competition with each other, they were cast in the same mold, and developed along parallel lines in each main theater, whether the tropical or extratropical areas of the new continents, or the Dry Belt, the Middle East, or the Far East of the Old World.

This worldwide imperialism, although dividing the lands among several sovereignties, was a standing proof of the indivisibility of the ocean routes and the interdependence of all parts of the earth. Its logic refuted certain of its practices, such as privateering, trade barriers and navigation laws. Although not evident until much later, it was already true that complete independence could be bought only at the price of complete isolation.

The European Impress

The world unit shaped by communication lines of least resistance and government imposed from Europe is made up of diverse societies unlike any of those regional worlds evolved previously in Eurasia.

European trading companies and governments planted trading posts, farming settlements, and mining camps on all the continents. Adventurers and seekers for independence penetrated into the farthest interiors of lands inhabited by peoples strange in dress, in color, in language, and in customs. On the harshest frontiers of this movement, individuals and groups might be submerged in the society they found. Many fur-trappers of North America adopted the Indian mode of life. Some Dutch farmer-pioneers in the South African steppe and desert turned nomads for a generation or two. More generally newcomers were forced to relinquish only part of their accustomed habits for ways better suited to the novel environment.

Despite numerous adaptations in customs, and alterations still more fundamental in modes of thought, the unending stream of emigrating Europeans has transferred overseas enough of the European way of life to overmatch the modes they have picked up from their new environment. The European norm was so firmly saddled upon the new continents that it came to be widely held as the standard for indigenes as well as folk of European antecedents.

Throughout the middle latitudes of these continents European blood has largely supplanted that of the aborigines, and adaptations to local environment are distinguishable only as variations from European ways and attitudes. In the low latitudes nature has imposed upon immigrants greater deviations from European backgrounds. Racial intermixture has been the rule, and the mixed societies carry forward a tradition in which aboriginal and European antecedents are mingled. After taking these modifications into account, it remains true that the stamp of European life marks all the new continents. The resultant similarity of outlook provides the nearest approach to a unified, worldwide view that has yet evolved.

In the already long-fixed horizons of the Asiatic worlds, the encroaching European imprint has been lighter. European economic methods have been adopted everywhere in the cities, and throughout some countries, as a practical goal promising increased wealth.

Government of the European type has also been imposed upon or adopted by several Asiatic peoples. With a few exceptions the yoke fits badly, as each year of the present century has increasingly demonstrated. Perhaps it needs only to be properly adjusted. Perhaps it is destined to be thrown off as unconformable to the long-set individualities of Asia. For four centuries, however, it seemed likely that the European system of government was destined to blanket the world. Many of its traits will doubtless remain embedded in whatever political systems eventuate in Asiatic countries.

European culture has not made a broad or deep impress upon any Asiatic society, except perhaps on certain of the tropical islands. Uplift undertaken high-heartedly in the 15th century, and continued until now, has been rejected in recent years, except for selected values, such as medicine.

By piecemeal trafficking, conquest, settlement, and domination, notwithstanding defects, a single world of a sort has been consolidated out of the numerous regional and primitive worlds that existed prior to the Discoveries.

Concomitant Warfare

Like the earlier expansions from local to regional horizons, the drive toward a worldwide sense of space was accompanied by fighting. The contestants were mainly Europeans, chief protagonists of the single world. The wars of the Reformation were the crucible in which crystallized the right of the European individual to determine his own outlook upon the world. This included his sense of space, however little attention he may have given it.

Intermittent wars raged for three centuries, kindled by the movement of Europeans into outlying continents. A manifest objective of these moves was to seize natural resources of the newly discovered overseas world. Such treasure could rarely be procured without the labor of the indigenes or

of immigrants. Practice proved that a line between economic exploitation and political domination could not be drawn. Groups assembled for labor had also to be governed. Only a few lands were enveloped by foreign trade without being wrested from their indigenous occupiers and transferred to the sovereignty of their conquerors. Owing to superior weapons, the Europeans won their battles, except rarely, when they were defeated by a combination of human enemies and tropical disease.

More rancorous than wars against aborigines were contests between European maritime states over the spoils of colonial conquest. Weapons were equally matched in these struggles. The mobility afforded by the ocean permitted them to be fought simultaneously in several continents, often with indigenes as allies of the European antagonists. The struggles for colonial spoils resulted in forging empires widely scattered over continents and islands. To the extent that they are rivals, they are incompleted and hence unsuccessful efforts to achieve political unity commensurate with the newly envisioned, worldwide geographic horizon.

Intellectual Consequences

In proving the earth to be a sphere the voyages of discovery rendered the concept of earth-space finite. The former regional concepts had been tentative, because every "world" had, as its limits, spaces unexplored and unkown but assumed to exist. Those unbounded spaces were now replaced by a sphere of known size.

Recognition of the world as finite did not reduce the vastness of man's sense of space. There remained the practical objectives of exploring the globe and determining the character of all its parts. This proved a long job, not completed until the 20th century.

There remained, further, the need to harmonize the several regional horizons and to subordinate them to the single, worldwide concept. Proofs of its validity were ample, and untrammeled thinkers promptly accepted it. Meanwhile, practical individuals all along the Atlantic seaboard of Europe took advantage of the new outlets it opened to their enterprise. In so doing, they disseminated knowledge of the spherical earth, while disregarding its philosophical implications.

It is not to be supposed that ordinary folk of the 15th century were suddenly illuminated by a revelation of the existence of the spherical earth, much less of its import. However conclusively the narrower views formerly prevailing may have been supplanted by the logic of scientific proof, they long remained embedded in the affections of large segments of the world's population. Probably a majority of people living today have never faced either acceptance of the worldwide horizon or rejection of it, because their

view is restricted by their narrow circumstances to a partial world that encompasses their thinking along with their daily existence. Such unconcern does nothing to advance human thought, but its effect is negative rather than retarding.

Not all of those who have paid attention to the world horizon have embraced it. Resistance to it has at times been active. Even now small groups follow leaders who rise to denounce the spherical earth. For a century and a half after its discovery, opposition kept pace with the spread of the idea. Powerful institutions felt endangered by the new outlook or unable to deal with problems it posed for them, and tried vigorously to stamp it out. Failing, they accepted it as one more item in the intellectual and spiritual awakening which had been transforming European thought ever since the first days of the Renascence.

Current Status

Exploration continued unabated from the early 15th century until expeditions reached both Poles at the end of the first decade of the 20th century. These exploits completed the adventure of setting foot on every considerable region of the globe—the goal which proof of the earth's sphericity had set for the spirit of human daring. They confirmed the worldwide geographic horizon, which had been envisioned five centuries earlier.

During all that time exploratory parties contended with nature without much benefit from technological advances. Some of the polar expeditions reached the ice by steamship, but once ice-bound they depended chiefly on drifting. Overland expeditions took to small boats when streams offered, and used draft or pack animals so long as any were available. But the final stages had to be made on foot. All modes of exploration remained, to the end, those of the two-dimensional world of the age antedating machinery.[4]

While the discovery of the Poles rounded out the era of the worldwide geographic horizon, the regional sense of space still marks the actual range of many minds. Even in lands where geography is part of a compulsory school curriculum, and among people who possess considerable information about the earth, the world horizon is accepted in theory and rejected in practice. A parochial outlook injects itself into every consideration of a political system more inclusive than the one in vogue, it appears in snap judgments on "foreigners," and it dims the view of existing interdependence in the economic order. This myopia is understandable. The weight of tradition is heavy. Until five centuries ago a primal or regional sense of space dominated human settlements everywhere. In the United States, where

[4] The one attempt to reach the North Pole by balloon failed.

society is mobile, it is easy to forget that even now few members of the human species move beyond their native region, and that hardly anybody has fruitful contact with folk who think in patterns different from his own.

The first world-encompassing sense of space greatly extended the range of human thought and action, but essentially in two dimensions only. It did not enable men to dig deeper than in former generations, because their limit was set by the ground-water table and their mechanical artlessness. It gave them no means of fathoming the upper atmosphere. In the common terms of everyday life, the earth is two-dimensional. Settlements are on the surface of the lands, with the negligible exceptions of cave-dwellings and houseboats. The land is the relatively homogeneous base for work and movement beneath the surface and for construction and propulsion skyward.

The Three-Dimensional Sense of Space

Recognition that the fixed locus of humanity is confined to two dimensions does not exclude other dimensions as auxiliary. Within a century after the unity of the oceans was demonstrated, man's sense of space was being enlarged in a new direction by scientific discoveries and mechanical inventions which opened to utilization the third or vertical dimension of the earth's surface. The concept of three-dimensional geographic space evolved slowly. It was not formulated until the present generation.

Sources of the Concept

Natural science grew out of the Renascence. Its procedure—observing nature, drawing conclusions, and inventing tools to aid in further observation—bore early fruit in the compound microscope (1590) and the telescope (1608). The new worlds laid open to view by these tools encouraged the founding of "royal" scientific societies throughout Europe. Most of them received their charters by the end of the 17th century. In the 18th they bore fruit in redoubled scientific attainments and inventiveness. Overseas continents recently brought into the orbit of Western Europe showed the earth to be more complex than earlier generations had imagined, and stimulated further scientific study and contrivance. Increasing knowledge about the earth disclosed new opportunities for developing its latent wealth. Through these several channels the Renascence appears as the source of the rivulet of invention which has become the flood of the present mechanical age.

The steps in penetrating ever increasing depths and heights are common knowledge. Wind and falling water, ancient sources of power, were set to run newly invented machines. To them were added new forces—steam, gas (internal combustion), and electricity.

One of the first uses of the coal-burning steam engine was to pump water out of a coal mine in order to dig more coal. Nowadays petroleum-powered pumps draw additional petroleum from far greater depths. Forced ventilation and compressed air make possible deep mining and tunelling. Many cities now have several storeys of service beneath their principal streets and buildings. Gas engines have made it possible to explore the ocean in the bathysphere, and to carry on warfare by deep submarine. Exploration of the atmosphere began with balloons, and flying (made possible by the gas engine) has both stimulated and aided study of the air. The convectionless stratosphere has been discovered and distinguished from the troposphere. Radio communication, by making novel use of the third dimension, aids flying and navigation.

While it is penetration of the vertical dimension of earth-space that distinguishes the new geographic outlook from its predecessor, the earth's surface has also been transformed. Electrical communication over land and sea is paralleled by new and varied means of locomotion. As a result, the pattern of communications is no longer set solely by the seaways. Rails have become integral links in global transportation, most notably in North America, but also in Europe, India, Argentina-Chile, and perhaps soon in Eurasia. Airways supplement ocean and overland routes. While in general they conform to the pattern of surface routes, they also tie heretofore inaccessible regions into the global system. It is also possible that a few new routes will link important terminal areas by shortcuts across wastes of desert, rain forest, or ice.

The scientific discoveries and mechanical inventions which have made accessible great depths and heights first appeared three and a half centuries ago, began to gather momentum two centuries ago, and became revolutionary within the past century.

Statements of the Concept

Wide-ranging human movement above and below the earth's surface introduced a new geographic sense of space. It was formulated only during recent decades. Two students have stated it, but in different terms and with different labels.

The first was Mackinder, who calls attention to the dependence of life and especially human life, on water. He conceives the geographic range as confined to the hydrosphere, "extending to those parts of the lithosphere and of the atmosphere which are interpenetrated by the hydrosphere."[5]

[5] Mackinder, Halford J.: "The Human Habitat," *The Scottish Geographical Magazine* 47 (1931), 321–35. Quotation from 325. This is a geographer's way of looking at terrestrial space. It embraces somewhat the same space as the biosphere suggested

The hydrosphere, a bubble of varying thickness at the surface of the globe, roughly corresponds to the combined space which mankind uses and occupies. Water, by changing its form and its locale, becomes the principal agent in creating, destroying, and conserving all the material aspects of the human habitat. Its abundance is one measurable determinant of the climate. In the long swing of geologic time, it enriches mineral deposits into ores having economic value. In a shorter course it is the chief instrument in weathering, transporting, and sorting (and thereby shaping) the surface mantle of the lands and shallow seas. It operates constantly to amend the soil, the natural resource from which mankind draws most of its sustenance and much of its shelter. Its availability determines the density and character of natural vegetation, and the kinds of crops that may be grown.

Closer view reveals discrepancies between the hydrosphere and the range of human activities. Waterless deserts are crossed by caravans and lived in by miners, while the icecaps, where water can be had everywhere, are unoccupied. Dry mines are worked and petroleum is drawn from depths below the hydrosphere, while rockets and planes ascend above it.

The second formulation of the concept is Vernadsky's. His noösphere includes all of the space man makes use of at present, and it allows for indefinite further expansion.[6]

Vernadsky begins with Lamarck's biosphere, only to extend it to presumed life on other planets. He then turns to the noösphere, the realm throughout which human thought operates upon and modifies the earth. This envelope he defines as including not only living matter but also inert matter. It appears to be the space accessible to science and invention, and so subject to utilization by man. It allows for extensions beyond the hydrosphere already made, and beckons onward in the third dimension.

Implications of the Concept

The size of three-dimensional space may be measured in terms describing the practical limits currently reached, or in estimates of its theoretical limits. The deepest wells stand at about 16,000 feet; the ocean has been plumbed to 2,600 feet in the bathysphere. Human beings have ascended to 74,000 feet, and airplanes are being made which normally fly at 45,000 feet. Very few students have supposed that man can effectively utilize the earth crust

by J. B. de Lamarck (Hydrogéologie, 1802). Another development from biology is the dynamic view of space as *Lebensraum*. This is recapitulated by Cahnman, Werner J.: "The Concept of *Raum* and the Theory of Regionalism," *American Sociological Review* 9 (1944), 455–62, especially § II.

[6] "Noösphere from *noos*, mind, and *sphere*, the last used in the sense of an envelope of the earth." Vernadsky, W. I.: "The Biosphere and the Noösphere," *American Scientist*, 33 (1945), 1–12. Quotation on 11.

beneath the sial, estimated to extend about 36 miles down. The atmosphere is presumed to fade out at a height of about 22 miles.

If the limits of the geographic horizon are fixed, the contents of terrestrial space are likewise limited. Hence they properly become a preoccupation of mankind. One result is revaluation of all the earth's store of natural resources—soils, waters, vegetation, animal life, and minerals. It can be measured crudely in the utilization of minerals.

Prior to the Industrial Revolution, by far the largest number of minerals in use were non-metals. They served mainly as building materials and for ornamentation, although coal and mercury were used in handicrafts. Tools and weapons were made from metals, of which only 10 were known, 8 being in common use. Coal came into its own with machines and factories. In the two centuries since elapsed, the employment of minerals, both metallic and non-metallic, has augmented at a progressive rate. During the past quarter century alone, 34 minerals have been introduced into industry on a commercial scale. Of this total 9 (including only 1 metal) have been put to new uses that have transformed them from unimportant to invaluable raw materials. Ten other non-metals and 14 metals hitherto unused have come to be produced in quantity. Different minerals nowadays figuring in commercial technology number about 65, but they appear in a far larger number of guises. There are said to be half a million products derived in part or in full from coal.

The volume of mineral output has increased no less remarkably than its variety. During the 20th century more mineral wealth has been taken from the earth than in all preceding time. For several decades, the outturn of a number of essential minerals has been doubling each decade.[7] Many of these increases have been made possible by deep mining and drilling—extensions into the third dimension of space. Commercial minerals come from widely separated sections of all the inhabited continents, but no single region contains a complete sampling. Hence their usefulness to the world varies according to the readiness with which they may be assembled from all parts of the earth for joint processing and to produce finished combinations. Any institution or tradition that interferes with free flow of raw materials, with their processing, or with worldwide marketing, delays the realization of the singleness of three-dimensional earth-space.

Reappraisal and novel employment of minerals illustrate the technological revolution which has opened man's way into the third dimension of space.

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[7] *Science* (n. s.), 74 (July 24, 1931), 10.

Leith, C. K.: *World Minerals and World Politics* (1931), *passim.*

Leith, C. K., J. W. Furness, and Cleona Lewis: *World Minerals and World Peace* (1943), *passim.*

While such material improvements have often been scorned by the general public at the outset, they are embraced with enthusiasm by all, save a few die-hards, when once their utility has been demonstrated.

Comprehensive changes in material technology are bound to affect every aspect of the social order. The character of the effects is hard to gauge, and their occurrence is rarely foreseen. When they make themselves felt they are likely to be repudiated or resisted. Examples from different aspects of contemporary society are illuminating.

On the North American Great Plains deep wells, agricultural machines, and railroads encouraged wheat farming. Breaking the sod was loudly applauded as progress until a series of dry years in that region of extreme and uncertain variation in rainfall created "dustbowls" and drove farmers out. Only then did the nation awake to a sober and valid appraisal of the regional resources and recognition of a fitting economic order for utilizing them.

In the Rhine Basin a number of sovereign states of contrasting culture were set up during an era when subsistence agriculture was the prime source of livelihood, and the small-scale trade could be shared without paralyzing economic life. When the river valley became a chief trade route of the world, and especially when deposits of high-grade coal and iron were discovered on opposite sides of political boundaries, the antiquated political vise became intolerable. Local passports, internationalized river traffic, customs unions, and international cartels are among the devices worked out to solve the economic problems caused by the numerous frontiers. They recurrently fail because of cultural dissidence which breaks out in repeated wars.

Maladjustment between the two-dimensional world apprehended a few centuries ago and the three-dimensional world perceived in the more recent past is not confined to scattered regions. During the earlier epoch a world-wide political structure was imposed by Western European states upon the rest of the world. It took shape in empires governed from Europe and in states economically subjected to Europe or voluntarily patterned after Europe. Until the early years of the present century this process continued to enmesh one region after another in the imperial patchwork so familiar from colored political maps of the world. True, for more than a century regions had been declaring their independence of European states, but thereby they merely changed flags, without altering the character of the total political structure of the earth.

Soon after 1900 radical changes appeared, all associated with intensified occupance and use of the earth. The Poles were reached, whereupon the surface area of all the continents and seas could be delineated on world maps. Africa, last of the overseas continents, was occupied by imperial powers,

thereby closing the way to large-scale territorial acquisitions at the expense of indigenes defenseless against European techniques. Japan, China, and Russia severally asserted their rejection of the European political system, along with many economic, social, and ethical institutions which had accompanied it to far parts of the earth. Unrest in India and the Near East rounded out the dissent of principal Asiatic regions from European tutelage. It became clear that the Asiatic continent was undertaking to develop its resources for its own advantage, rather than as part of earthwide reciprocity.

Scientific study began, a little before the turn of the century, to bear fruit in inventions essential to reach great depths and heights. These included the turbine, the internal combustion engine, the airplane, and electrical communication and propulsion. With their aid the third dimension of earth-space is being disclosed.

Every advance in the vertical plane alters the potential capacity of the earth, by providing humanity with new means of operating on the two-dimensional space it inhabits. Extension of man's range thus multiplies his power, rather than adding to it. The simultaneous closure of the era of surface expansion and opening of unmeasured potentialities latent in a three-dimensional world are setting new values upon every part of the earth.

As in each earlier expansion of the horizon of geography, the three-dimensional conception has accompanied far-reaching changes in the variety and volume of production. Natural resources are being reassessed. A barren islet may become a vital link in the system of world airways. A state may find its territory enhanced or diminished as a national property. Standing in the way of reappraisal and novel utilization of the earth is the structure of political society that was worked out in conformance with the world of two dimensions. Efforts to control and distribute the newly realized values have ranged from economic reciprocity to conquest by armed force.

Wars of the 20th Century

The aggressors in the War of 1939 have repeatedly justified their bellicose moves of previous and succeeding years as efforts to redistribute the natural wealth newly materializing. Their claim is admitted in some quarters among resisters. Aggressors in the War of 1914–18 had in view the same objective, stating it as a demand for "a place in the sun." During the 20th century dissatisfied Europeans devised a design for conquest intended to recast the world of multiple sovereignties into a few immense pan-regions uninterrupted by foreign territory and as nearly self-sufficient in all three terrestrial dimensions as the conformation of continents and oceans permits.

The wars of the 20th century differ from earlier conflicts in being three-dimensional and also in being truly global. They are integrated not by claims to territory scattered about the earth or to battles fought in several continents, but by engulfing every region of the earth and every walk of life. They have made the first effective use of flight and of undersea weapons, and they have prodigally expended natural resources drawn from the deep earth and from the air, as well as from the surface. They leap across the surface battle lines to bombard every part of belligerent territory. They require participation from practically every able-bodied civilian, and they endanger his supply of food no less than the flow of munitions to the armed forces. To these ends they employ not only blockade by sea, but also economic warfare. With radio messages they assault the minds of belligerent peoples with the weapons of psychological warfare.

It is asserted that the destruction these wars strew is so intolerable that each conflict must be the last. Nevertheless, a second world war is being fought in spite of dire predictions made at the close of the first. There is no evidence that a third will be prevented by fear of destroying civilization. Possibly the devastation in wars nowadays is not greater in ratio to resources than was destruction by wars of earlier centuries.

Viewed as incidents in the expanding sense of space, 20th century wars mark a departure, not only in scope and incidence, but also in objective. Their goal is not colonial empire. Instead, it is the intent to break down political and economic barriers that interfere with unit exploitation of the vast potentialities within the newly apperceived geographic horizon. This objective threatens every existing society on earth and brings all nations into the struggle.

The world may insist on remaining a patchwork of states. It cannot indefinitely reject the three-dimensional sense of space. Continued intensification in the utilization of earth-space will compel integrated use of natural resources, wherever they may be found. The anticipated technological advances will in time induce peoples to accept inevitable alteration in the social order. Whether it will be imposed by war or adopted by compromise only the future can divulge.

The most broadly envisioned three-dimensional earth is a thin envelope at, and just above and below, the surface of the globe. Further examination of this geographic horizon promises to extend it somewhat in the vertical plane, but within conventional geometry no new dimension of the sense of space is conceivable.

PART TWO: A MULTI-DIMENSIONAL GEOGRAPHY

It should occasion no surprise if a new geographic horizon can be descried before the old has become ingrained in the general thinking of man-

kind. Chronological overlap need not disturb the view that successive stages of the sense of space are philosophically distinct from each other. Neither an era nor a mode of thought breaks off short at the entrance of its successor. Rarely is the new set of values recognized until it has made considerable progress. It may be discerned only vaguely until long after it has begun to alter the structure and the pattern of society.

While mankind's sense of space has been expanding, the retreating horizon has not become more vague. Paradoxically, it has been brought into sharper focus with each extension. Explorers seeking new lands brought back a knowledge of the size and shape of earth features never available to the earlier ages when an unknown world lay beyond the horizon. Every farther flight into the stratosphere, every discovery of deeply buried minerals, every advance in human comprehension of the nature of matter, reduces the area of the unmeasured and adds to the delineation of the earth-habitat as the noösphere.

In terms of the traditional three dimensions of space, the geographic horizon is finite, so long as rockets return to earth. But already, before its bounds are fully demarcated, the geographic horizon is seen to transcend the dimensions of geometric space into the element of time.

To a primitive community time has little significance. In the uniform and seasonless climates where early human beings appear to have evolved their primal sense of space, time was scarcely noticeable amid pressures of more tangible surroundings. The advancing civilizations that learned how to irrigate the soil, as in the Nile Valley, learned also to take cognizance of the annually but not punctually recurrent rains or floods, which alone made their living as farmers possible. Once established in its cycle, life went on for hundreds or thousands of years with scant change of pattern and less alteration in structure. Similarly, the slow pulse of China indicates the relative unimportance of time, until the present generation, to another segment of mankind. Nomads have always lived with the drift of the sky and have had to adapt their migrations strictly to the erratically recurrent rains. Their accurate observation of times and seasons is shown by their literature (notably the Hebrew Old Testament and the Arabic Koran). The Christian world borrowed some of these observances through the Bible, along with traditional celebrations inherited from Classical Antiquity. They were embodied in the deliberate tempo of the ecclesiastical calendar to which the Middle Ages conformed. Time, as understood in medieval Europe, meant little besides keeping track of dates.

The opening out of the worldwide horizon by overseas activities instilled a quickened sense of time. Seasons in different parts of the world vary, the length of day and night differs. Currents and winds shift. The trader,

warrior, or other link between two regional worlds had to take account of the grosser differences in time in order to profit fully from the variation afforded by his expanding sense of space. Thus Da Gama and his successors observed the seasons, sailing to India on the "wet monsoon," returning with rich cargo on the "dry monsoon."

The three-dimensional world has compelled its inhabitants to adopt a still stricter sense of time. Excursions into the atmosphere, the ocean depths, and the solid earth can be made only at the price of a careful watch upon time. The machines and other inventions by which the vertical dimension of space has been penetrated are themselves factory products of sedulous timekeeping.

Today many specialists work on a carefully timed schedule. Radio programs are synchronized. Chemical processes are successful only when subjected to rigorous control of the time required for their fruition. Many mechanical and electronic operations function in split seconds. The ordinary citizen is increasingly aware of time. Every acceleration of circulation has compelled closer preoccupation with schedules and with timing. Traffic accidents, a new major hazard to life, are likely to be caused by misjudgments of time. The city dweller of today lives by the clock. The increase in accuracy of timepieces, and their widening diffusion, are symbols of the fact that life moves in a time-dominated world.

A New Earth-Dimension

Now, almost as soon as the configuration of three-dimensional earth-space is formulated, come hints that the geographic horizon is multi-dimensional, in being conditioned by time no less than by space. There appear to be three expressions of time for the geographer to take account of—three further aspects of the sense of space. Perhaps it will not do violence to the language of mathematical physics to call these derivatives of time the fourth dimension.

Velocity

The first derivative of the time dimension is velocity—the speed with which area is covered. This extension of the sense of space has recently been much discussed. It underlies the well-publicized concept of "the shrinking world." It is partly, perhaps largely, a function of mobility both in transport of persons and goods and in communication between persons.

Velocities currently attained are basically conditioned by certain discoveries and inventions of the past century or so. Prominent among them are steam and gas engines, electricity in several aspects, cheap steel, and the lightweight metals. Each separate trajection has its own velocity, which can be measured as the ratio of distance covered to time consumed.

Pace

Another derivative of the time dimension is pace—the rate at which human life moves in its dependence upon and use of the earth. Pace is the average tempo of trajections in a specified area. It is slower on the Rhine Delta, where there are many canal boats, lift bridges, and bicycles, than in central Iowa, where railroads, motor cars, and fixed bridges are the rule. The fastest North American trains today attain velocities little greater than railroad records set half a century ago, but the pace of American life has been accelerated during the last five decades, partly because the velocity of ordinary trains is greater.

The rate at which coal is removed from a mine or the rate at which impoverished soil is replenished by adding fertilizer, or the average rate of the movement of persons, mail, or a given class of goods, are among the many items which, in sum-total, determine pace. To measure it would require a long-term accumulation of such data.

Timing

Still another derivative of the time dimension is timing—the synchrony of occurrences at a particular place. Occasionally this coincidence is accidental or fortuitous, as when the invasion of England by William of Normandy chanced to synchronize with the appearance of a brilliant comet. Contemporaries described the incident, but subsequent generations have been the discoverers that it acted as an important instrument of psychological warfare. In past ages, it was rarely possible to insure accurate timing, because considerable leeway had to be allowed for nearly every sort of trajection. Today timing has moved into the forefront of attention as an essential element in management.

Its value is especially noticeable in war, as in the timing of the 1944 invasion of Norman beaches to the period of highest tides at the commencement of summer. (Delay of the operation by rough weather, and storm damage to one of the major installations, calls attention to the uncertainty of timing, even today.)

By definition, timing has to be planned in order to be more than chance coincidence. The trajections involved must therefore be measured in advance as accurately as the objective warrants and circumstances permit. If trial tests are feasible, the margin of error in the estimate can be corrected.

Time and the Sense of Space

The enlargement of the horizon of geography by the three expressions of time will be best seen by considering each of them in relation to the others. The swifter the velocity, the more exact the pace, the more critical the timing.

War and the New Dimension of Space

In 1815 it was possible to fight the most successful battle of our Second War with England after the peace treaty had been signed, and therefore wholly without effect upon the terms of peace. The time required for sailing vessels to cross the Atlantic withheld news of the treaty for many weeks after it was agreed upon by American representatives in Europe. Strategic timing of the battle was impossible, because the pace of the peacemakers and of the armies, and the velocity of communications between the two were independent of each other.

Half a century later Bismarck scheduled his wars for the unification of Germany on a rough timetable. All three wars were determined upon before the first was launched. The pace of battle was attuned to the new device of steam railroads, whereby armies could be moved with unprecedented speed. Each war was timed to begin with a swift attack. Defeat of the defense was anticipated as the penalty of slowness; victory of the aggressor the award to speed.

In the present war the time dimension has been given elaborate exposition. This is true of both Japanese and German plans, but the latter will serve for illustration. The general procedure was worked out in detail for both political and military strategy. Alternative moves were held in mind, to be carried out as the fortunes of battle might dictate or permit. The pace was to be that of motorized equipment—tanks, trucks, airplanes. Using these means of rapid locomotion, velocity of attack, "blitzkrieg," was designated as being the most effective means to conquest. Again and again this procedure succeeded.

Timing was scheduled with refinement beyond anything hitherto undertaken. The war was postponed until no further territorial gains could be extorted by threats. Once this point of time was reached, the war was unleashed at the season when the major crops had been harvested throughout Europe, and were therefore in store for the prospectively victorious army and people. During the autumn designated, the attack (to be made upon Poland as the most isolated of the resisting nations) was launched at the beginning of the three weeks of the year which climatic records showed were likely to be least rainy, and therefore most favorable for swift deployment of mechanized transport and guns, in a moist land of dirt roads.

Each successive offensive move while the pre-planned victories of Germany (and later those of Japan) continued, was based on attack of utmost velocity, paced faster than the sluggish movements of the unprepared enemy, and timed to take advantage of weather, water, routes, seasons, drainage—in short, of every pertinent aspect of the natural environment. By making painstaking use of time in relation to space, the aggressors extended the

radius of their synchronized tactical operations beyond anything the world had hitherto known.

Communications and the New Dimension of Space

Wars admirably illustrate the temporal dimensions of space, by bringing into bitterly sharp focus the pertinent conditions and events. Communications are less spectacular than warfare but they contribute more permanently to the rearrangement of the patterns traced by humanity upon the earth.

After centuries of stagnation, the velocity of transport has been increasing for nearly two hundred years. In recent years new speed records have been set every few months. All three media of the hydrosphere are involved: on water, transoceanic crossings by the 75,000-ton turbine ships of the 1930s; on land, transcontinental trains carrying heavy freight or numerous passengers on rails, and small-bulk movement over paved roads by motorcar and truck; in the air, planes carrying special categories of traffic indifferently over land, water, and ice without transfer of load.

The acceleration has been aided more than is commonly realized by telegraph, telephone, and radio, three progressively more adaptable means of keeping tab on fast-moving vehicles.

Record velocities are rarities; increase of pace depends on average speed. This has stepped up with each major invention in transport and communication. Progress differs, from region to region, with the feasibility of installing recent inventions and equipment, but only the most remote and sparsely inhabited areas still move at the pace of the early 19th century. The radius and system of public transportation and communication do much to determine pace. A factory having untrammeled access to its natural trade territory can receive and fill orders so fast that retailers need carry little stock—in some lines not more than samples. A person with a through-return ticket to a distant point can transact his affairs with a minimum of delay.

Immediate contact has eliminated the cushioning time lag which had uses in softening the impact of intercourse. The intermediary emissary may be dispensed with or reduced to the office of messenger, as when heads of states or businesses talk over the telephone, or meet face to face, leaving their ambassadors or their representatives little responsibility.

Even when authority is delegated there is no longer an unavoidable interim, giving opportunity to ponder a problem, and the aid time itself often lends to the solution.

Timing in communications has been made possible by inventions of the past half century. The telephonic conference of scattered business or government executives is a commonplace. With somewhat less precision, letters

or goods can be dispatched to arrive within a few hours of a specified time. Ships, trains, busses, and airplanes maintain announced schedules, interrupted only by catastrophes or severe weather.

Communication has always been the cement of social groups. The revolutionary acceleration on the world's routes is already at work to change the pattern of society.[8] The resultant friction can lead either to economic coordination and political affiliation, or to autarky and isolation. The direction of progress is clear; the course human societies will take is unpredictable.

Reciprocal Use of Earth Resources

The day when each small segment of the earth produces all or most of its requirements is being swept away by the onrush of rapid transport. The motor car and truck bring suburban gardens to city consumers. Refrigerated ships, trains, and trucks carry out-of-season perishables to markets thousands of miles distant. Air transport has made a beginning in a further acceleration of long-range marketing. In return, innumerable manufactures of city and town reach country folk in hours or days, instead of weeks or months. This process should lead to maximum production, taking the earth as a whole, because each place can be organized to specialize in the activity for which it is best fitted by nature.

Full advantage of regional reciprocity comes only when speed is governed by timing. The parts of complex machines are commonly made in different places, each element where conditions are exceptionally favorable. By careful timing, the parts are made to flow to centers where they are assembled into the finished machine. Much the same thing occurs in a world market. Grain or fleeces, fruits or salmon are perforce harvested at the season appointed by nature. Advantage is taken of the seasonal flow and ebb of production in opposite hemispheres or other contrasted environments to equalize the quantity reaching the principal consumers from day to day througout the year.

With all regions of the earth contributing to and drawing from world pools of goods, the pace of economic life is steadied. Long seasonal lulls are giving place to more evenly distributed work. In slack seasons labor may migrate, while management takes a vacation. Rushes at the peak seasons are harder to avoid, especially in agriculture. In other businesses they are less acute than they were when each region lived largely to itself.

The bright hope in prospect with timely reciprocity in use of the earth's resources is dimmed by miscarriages in realization. Some nations have

[8] The reduction in transport time is not equal at all places or in all directions. Boggs, S. Whittemore: "Mapping Some of the Effects of Science and Technology on Human Relations," [United States] Department of State: *Bulletin*, 12 (1945), 183–8.

recently adopted a policy of autarky in order to equip themselves for waging wars of conquest or to recast their internal economy. Others have substituted protective tariffs for free trade. Elsewhere administrative regulations cut down the free flow of traffic inside national boundaries. The swing of the business cycle has been intensified as regional specialization has supplanted production for local subsistence. When added to seasonal lulls it may create unprecedented unemployment. Laws passed in one country to alleviate the evils confronting it, frequently drive reciprocal regions into equal or worse straits.

Plainly, further advances in reciprocal production over the whole earth will depend largely upon improved control by the social order. This may take the form of cooperation between the sovereign states, or a merging of sovereignties into a unit commensurate with the economic world.

The Balance of Conservation and Destruction

Less tangible, but no less important than regional reciprocity in production, is the balance between destruction and conservation of natural resources.

In any region unoccupied by man it may be assumed that a balance between reduction and restoration of earth resources is struck by the operations of nature. Each natural environment thus approaches or reaches a norm which remains unchanged unless nature sets new forces in motion. E.g., onset of an ice age, establishment of a new base level, firing of a forest by lightning. Man's interference with the natural balance has only recently been recognized and subjected to impartial study.[9]

Wherever primitive tribesmen have held sway, human interruption of nature's balance has generally been local in extent and impermanent in impress. For example, prolonged extraction of iron ore from lateritic soils of Middle Africa was so small in scale that it did not impoverish the meager regional supply. Again, shifting cultivation in rain forests affects only scattered spots, and these are reclaimed by nature. In a few places, practices of primitive man appear to have upset and permanently altered the balance of natural conditions. An instance is the custom of annually burning the grass throughout wet-and-dry Africa. Tree growth is thereby stunted, some species are killed out, and the soils gain potash at the expense of humus.

Expansion of the geographic horizon is usually accompanied by intensified disturbance of nature's balance. The original forest cover of hilly and mountainous parts of China has long since given place to bare, eroded hills or to scrubby thicket having little value, while flatter lands have been enriched as diked paddies. China has not dipped deeply into its mineral re-

[9] Whitaker, J. R.: "World View of Destruction and Conservation of Natural Resources," *Annals Association of American Geographers* 30 (1940), 143–62.

source. Operations have been confined to the two-dimensional area of occupance. Western technology is more thoroughgoing. Huge acreage of soils is depleted, in places ruined, by machine methods of tillage that modern inventions have put into the hands of every farmer. Water supplies have been pumped for irrigation at rates far in excess of replenishment, to the ultimate detriment of the users. Extraction of minerals threatens to exhaust not merely small deposits, but also major enrichments. Depredations have made serious inroads into many vital natural resources. All three dimensions of earth-space are affected.

The rate of destruction and the area disturbed vary from time to time and from place to place with several conditions: the delicacy of the natural balance; the fragility of some or all of the resources; the intensity of human need; the implements with which man is equipped; the attitude of the social group torward the use of nature's stores. Only a beginning has been made in evaluating these conditions, and in viewing them, region by region, as critical for the future of the contemporary world. A generation of emotional natural history which has worn the label "conservation," has paved the way for a dispassionate study of the conservation of natural resources as an aspect of geographic science.

The utilization of natural resources may be either useful or abusive. In both cases, the time relation between their destruction and their regeneration is as critical as their distribution in three-dimensional space. No true appraisal of resources can be made, whether for the earth as a whole or for its parts, unless due consideration is given to the pace of their consumption and replacement, as well as their quantity and distribution. Proper conservation of natural resources may be defeated by failure to attach due importance to the time element in the destruction and conservation of the earth's endowment.

Four-Dimensional Geography

If the four dimensions of space be accepted as valid, how may they function in the work of the geographer? By profession in the vanguard of those who ponder the human habitat, the geographer habitually thinks in terms of the three geometrical dimensions. Vistas that include velocity have been glimpsed by most geographers in recent years, while pace and timing have been occasionally noted. As geographers accustom themselves to include all three derivatives of time within their horizon, they will gain a new tool with which to work.

Physical geography needs restudy in sharper focus if it is to give adequate support to a four-dimensional human geography. For some time it has

been seen that local climate awaits investigation by means of data not commonly in use. Many of them cover short or irregular periods of time.[10] An understanding of local climate will clarify many hazy generalizations and debatable issues in nearly every phase of geography: crop growing, incidence of disease, military tactics, to mention obvious instances. The geography of soils is in its infancy. Students of land-use need to know the tempo of degradation and regeneration of this most valuable of natural resources. Attention to the geography of animal life, especially that of insects and still lower forms, will open a field of study now virtually untilled except occasionally by medical men. Seasonal incidence of disease and the effects of animal life on the pace of human societies are samples of the time factor in this neglected aspect of physical geography.

Students of economic, social, and political geography can refine their research and clarify their presentation of the time derivatives in topics dealing with contemporary society. The American village may serve as example. Its character and function are quite different today from a generation ago. The motor car has transformed villagers into suburban members of the nearest city. Railroad service has been withdrawn as the use of trains has dwindled. Main Street no longer caters to all the varied wants of the community, but only to the daily needs that do not warrant the easy trip to the city. Increased velocity of transportation has changed the pace and radius of movement, and all three have set a new value upon timing. Effects appear on the map of land use in the village, as well as in the less tangible phases of local geography.[11]

Further examples might be drawn from all branches of cultural geography. One will suffice. Commercial fisheries have been shifted in location and changed in character by the introduction in quick succession of the tin can, the refrigerated ship, railroad car, and motor truck, and the process of filleting. Each of these devices altered the time values and consequent space relations in the handling of a highly perishable product.

Historical Geography

Introducing velocity, pace, and timing into geographic study brings to the surface the inescapable fact that human occupance of the earth is a continuing process. The reaction of human society to and upon its habitat is often assumed to be significant only in its present-day manifestation. On the contrary, the habitat of today may be compounded of elements varying in age from this year's "dustbowl" to a deposit of native copper in

[10] Visher, S. S.: *Climate of Indiana* (1944), introduces some of these data.

[11] Stewart, Oliver: *Air Power and the Expanding Community* (1944), is a stimulating essay bearing on this phenomenon.

the earth's basement rocks, and every social group continues to use increments from its past as tools for living in the present habitat.

The existence in today's society of holdovers from all the past environments has been recognized by both geographers and historians. Until recently, workers in both disciplines have concurred in segregating the natural environment and treating it as a persistent influence on the course of history.[12] In so doing they have created a history which accents the role of the environment, just as other students have written history accenting economic or psychological factors.[13]

This environmentally conditioned history has customarily been called "historical geography." Historians generally have accepted the emphasis thus given to geography as a welcome contribution to their subject. The viewpoint has markedly influenced historical writings of the past three or four decades. At the same time, some historians have warned against considering the natural environment as more than a single factor among many items figuring in the march of events. Until recently, geographers who contributed to this branch adopted the standard model for their work. A few have always questioned calling it geography, because it is organized in the chronological frame traditionally the province of history.[14] A growing number rule it out of bounds on the ground that it is history. They do not thereby extirpate the perennial demand for integral study of man's continuing occupance and use of the earth as necessary for a full comprehension of geography. It appears likely that in future, as in the past, studies in this broad field will be made by geographers, not by historians.

To satisfy the demand in geographic terms, historical geography is being redefined literally, as the geography of chosen periods of the past. The investigation cannot be made in the field with the usual techniques of the geographer; records of observations made at the time selected for study are substituted for field data.[15]

Such a study is indubitably geographic, and can be judged with propriety by geographers. No series presenting the geography of consecutive earlier

[12] Semple, Ellen C.: *American History and Its Geographic Conditions* (1903, 1932).

Turner, Frederick Jackson: *The Frontier in American History* (1920).

East, Gordon: *An Historical Geography of Europe* (n. d., *ca.* 1936).

[13] Beard, Charles: *An Economic Interpretation of the Constitution of the United States* (1913).

Hook, Sidney: *The Hero in History* (1943). This is mainly an objective inquiry, but Chapter 10 is an exemplification of the title.

[14] Sparks, Edwin Earle, *et al.:* "Report of a Conference on the Relations of Geography to History," *American Historical Association Report, 1908,* vol 1, 57–61.

Hartshorne, Richard: *The Nature of Geography* (1939), 184–5.

[15] *Ibid.,* 185–8.

Brown, Ralph: *Mirror for Americans* (1943).

periods has yet been prepared for any large area.[16] When done, the series would presumably recreate the geographic landscapes of all the epochs for which records can be found. From studies which have been made, it appears that much of the matter would have no relevance to present-day geography of the area. The sequence of wanted items might be culled from the facts presented, but it would not leap to the reader's eye and mind. This historical geography has already established itself as a corrective to the shallow, contemporaneous view of geography, and it is making a signal contribution to geographic knowledge. Nevertheless, it is historical in only two senses: it employs techniques of historiography and it presents material of antiquarian interest. It omits the compelling time sequence of related events which is the vital spark of history.

Is there a solution for the puzzle of writing incontestable geography that also incorporates the chains of event necessary to understand fully the geography of the present day? A promising approach is suggested by the recognition that time can be reckoned as the fourth dimension of geography. In introducing his lectures on geography, Kant grasped the unity of time and space as essential to the geographic way of thinking. "We may classify our empirical knowledge either according to conceptions or according to time and space where items are actually found. . . . Through the first we obtain a system of nature, . . . through the second a geographical description of nature."[17]

It is incontrovertible that the prime essence of geography is space. (Recognition that in geography space means terrestrial area sets aside the age-old philosophical argument as to the character of space.) Earth-space is a complex of various features of nature, or of nature and culture. The possible combinations take form in relatively few patterns. These are recognized and described by geographers as "types."

Any specific arrangement of earth-space becomes fully intelligible only when it is linked with preceding combinations of nature and culture in the same area. The genetic function of the passage of time contributes to every space arrangement. Indeed, the coherence of the features of an area varies roughly with lapse of time. This is true where natural conditions alone are concerned. Thus, an uninhabited wilderness occupied by pioneer vegetation becomes something more than an observed isolated fact when it is

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[16] Small areas have been so treated, E.g., Thomas, L. F.: "The Sequence of Areal Occupance in a Section of St. Louis, Missouri," *Annals Association of American Geographers*, 21 (1931), 75–90.

[17] Kant, Immanuel: "Physische Geographie," Königlich Preuszischen Akademie der Wissenschaften: *Kant's Gesammelte Schriften, Erste Abtheilung: Werke*, Neunter, Band, 159–60. A republication of Rink's edition of Kant's lectures.

seen that its present stage is a consequence of conflagration set by lightning and a precursor to regrowth of the climax vegetation. Where nature and culture interact, the areal coherence imparted by time often plays a still more impressive part. Thus, Switzerland has become a nationality through seven centuries of mutual endeavor, growing out of the use of favorable trade routes across the Alps.

So significant is the time element in geography that each field where it overlaps related disciplines is distinguished by a temporal as well as a spatial character. *E.g.,* climatology is set apart from meteorology in being a summary of weather data collected over a considerable period of time; agricultural geography is the long-term summation of farm practices. Furthermore, the geographic aspects of several sciences are organized around a generalized figure deduced from observing the symmetry and recurrence of pattern in nature. Full-scale examples are the cycle of erosion, the maturing of soils, and the climax of natural vegetation; the alternation of humidity and drought in regions of small rainfall is a partial exemplification. Where both natural and cultural circumstances interact, symmetry and recurrence have likewise been traced. Although their delineation is less sharp than in natural science, working hypotheses based on observation of them prove useful in geographic aspects of social studies. Examples are: the succession of economic pursuits among primitive peoples as they advanced their technology in a given natural environment; the business cycle in contemporary industrial society; the rise, spread, and blighting of urban zones, as cities grow; the alternation of land-use in regions of unreliable rainfall; the repetitive occurrence of human action in a given environment.

It follows that no statement of geography is complete unless it takes cognizance of the factor of time. In this sense, all geography is historical geography. The frame within which any part of earth-space is discussed needs to include both its areal bounds and its temporal sequence. If, as is usually the case, the present stage in the sequence is under survey, the temporal limits are to be found only in the direction of the past. If some past stage of occupance or the genetic sequence of all known stages of occupance is being presented, the temporal limits run both backward and forward.

Studies made so far have not provided clearly designed patterns for the sequence of human occupance of earth-space. The vagaries of human action have delayed and may prevent the discovery of a pattern analogous to hypotheses such as that of climax vegetation. A glimmer of coherence appears, however, if the sequent stages in human occupance of earth space are set against a background of mankind's evolving sense of space and time.

Since its primitive beginnings, man's perception of the relations of time to space has notably broadened and sharpened. The sense of space prevailing at any time and place marks the current limit of range in human occupance and use of the earth. The progressive states of the geographic horizon therefore mark off the major divisions of historical geography conceived as a sequence of genetically related stages of earth-occupance. In each stage it is important to know the geographic horizon not only of the people under study, but also of outside groups with which they are in contact. For instance, the worldwide outlook of British immigrants to New Zealand gave them a mental advantage over the Maoris, whose outlook on the world was limited to a primal sense of space bounded by their islands.

Within the broad confines of each of the major divisions, the reaction of culture to and upon nature varies from place to place and alters with the lapse of time. The areal variation is explicit in all geography. The temporal modification is frequently disregarded.

Some of the elements at each stage of occupance are subject to alterations very slow or slight, and so appear as constants in the sequence. The stable items include persistent traits of the people (perhaps mainly psychological), and those aspects of the natural environment not being markedly modified by the current technology. Other elements are subject to swift or sweeping change. The unstable items include technological advance or retreat, fluctuating economic procedure, and changing social and political institutions, along with associated critical modifications of the natural conditions. Changes of phase resulting from notable alterations of these sorts fix the limits of minor divisions of historical geography.

Material for this kind of historical geography selects itself with reference to the evolving sense of space and the mutual modification of nature and culture that eventuates. A study so organized moves forward stage by stage with the sequence of occupance and use of the area, *i.e.*, stepwise, as the interacting natural and cultural elements change pattern or structure or both. It is chronological in arrangement, but spatial in treatment. Thereby it is made true historical geography.

Illation

The present epoch is generally conceded to be critical in human history. Scientific discovery and invention have accelerated technological progress at a swiftly rising rate. The entire earth has been integrated into a closely knit economic unit. At the same time, large groups of the world's population suffer from recurrent economic depression. Two world-engulfing wars have befallen a single generation, each destructive beyond all precedent. All these facts appear to be connected. Their import is not so clear.

Many people believe that continued scientific discovery and invention will maintain the accustomed rate of technological betterment, finding unlimited scope in the three-dimensional world which has been opening to view during two centuries. Their anticipation amounts to a tenet of faith, unshaken by economic or political upheavals.

Countering this belief is a reasoned opinion that the traditional avenues of expansion, long established in the two-dimensional earth, are facing closure. This view was announced years before worldwide depression and worldwide war shook the structure of society (thereby, in a sense, confirming the prediction). The geographically minded historian, Turner, forecast revolutionary consequences to American society with the end of free land in the United States. His thesis would also apply in other parts of the world open to settlement from outside. The historically minded geographer, Mackinder, envisioned worldwide repercussions of expanding social forces on an earth closed to further territorial expansion in the political sense.[18]

As an alternative to both of the current attitudes—faith in unlimited but unspecified scientific achievements, or documented expectance of frustration to advancement—I have posed a far-ranging view of geography that takes account of the two-dimensional earth on which we live, the three-dimensional earth which we are already using without occupying it, and a four-dimensional earth which appears to afford scope for continued regulated advance.

My procedure has been to recapitulate the steps in humankind's enlarging sense of space, to estimate the point in that progress where the perception of space stands today, and to adumbrate a mode for studying and presenting geography which sees the subject whole, while keeping uppermost the space relations of phenomena, and arriving at a vantage point from which the future path of earth-conditioned society can be descried.

The recapitulation will profit from critique by geographers, the estimate needs the perspective which the passage of time will give, and the adumbration calls for exemplification. Geographers who, at my request, have criticized the manuscript have emboldened me to ask for the further criti-

[18] Turner, Frederick Jackson: "Significance of the Frontier in American History," *American Historical Association Report*, 1893, 199–277.

Mackinder, Halford J.: "The Geographical Pivot of History," *Geographical Journal* 23 (1904), 421–44.

The parallel view of these authors has been pointed out by Malin, James C.: "Space and History: Reflections on the Closed-Space Doctrines of Turner and Mackinder and the Challenge of Those Ideas by the Air Age," *Agricultural History* 18 (1944), 65–74, 107–26.

cism which publication invites. In its present form the paper owes much to the helpful guidance these critics have given.

Harvard University
February, 1945